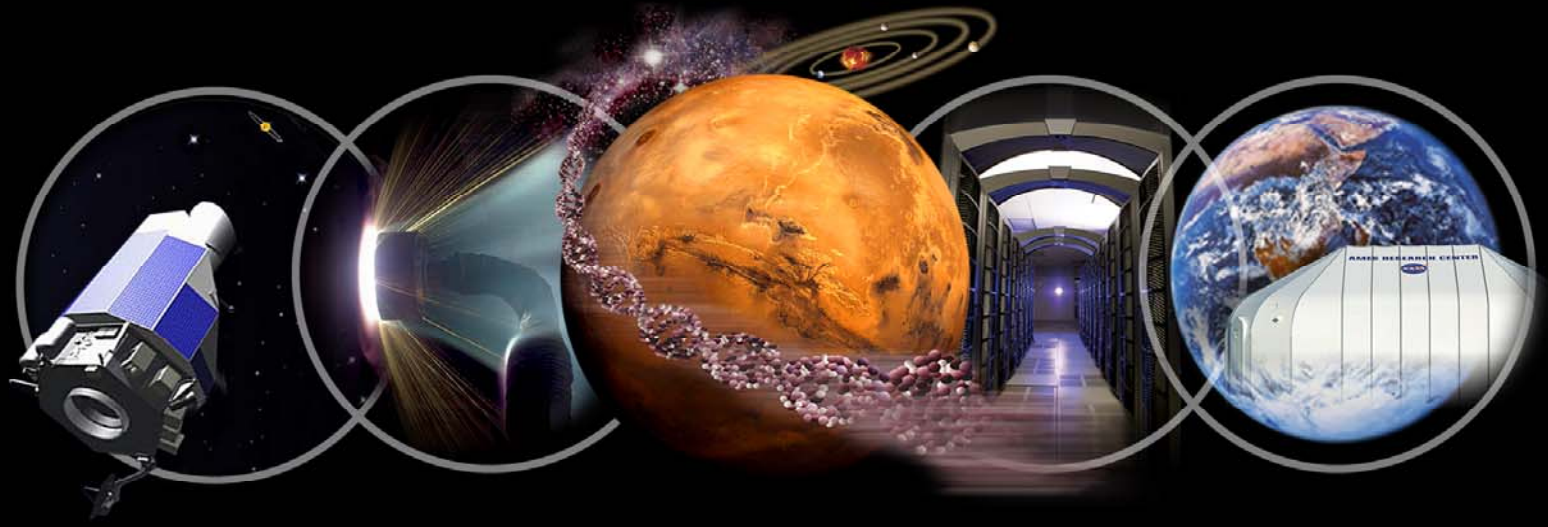
Discovery ➲ Innovation ➲ Solutions



System Design and Mission Simulation

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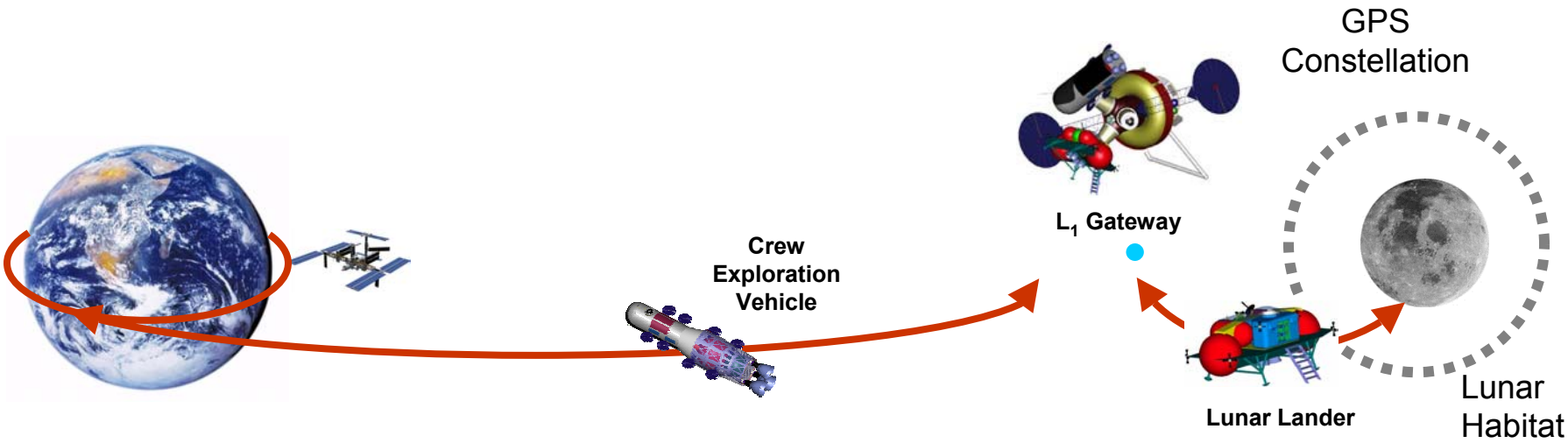
Ames Exploration Systems Technology Partnerships Forum
July 22-23, 2004

Visibility ➲ Excellence ➲ Impact

Ames Research Center

System Design and Mission Simulation

Simulation Support for Spiral Development



SIMULATION SOLUTIONS
- Advanced Design Tools
- Visualization
- Controls and Displays
- Training
- Human Factors
- Automation
- Distributed, Collaborative Environments

• • •

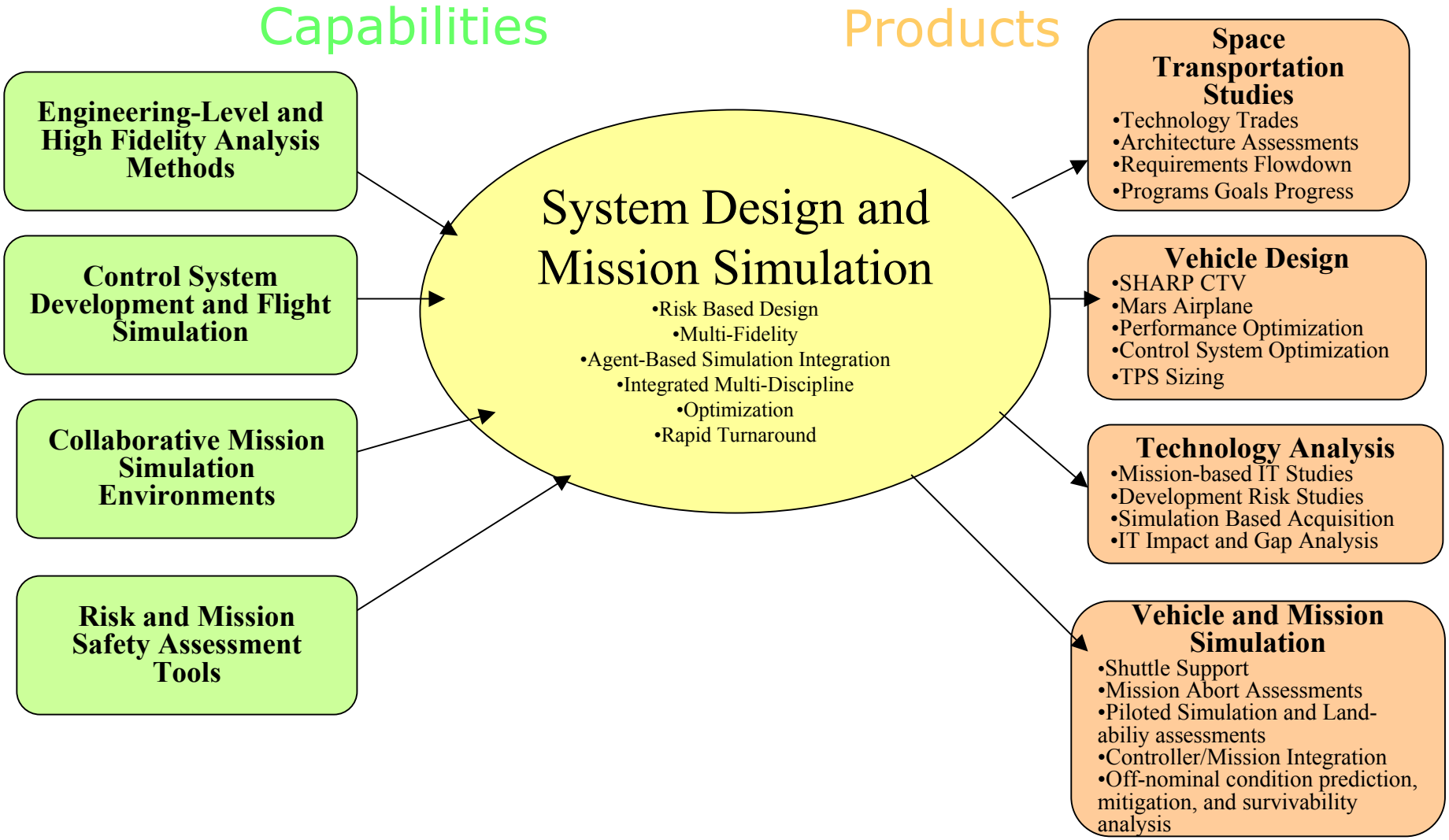
MISSION ELEMENTS
- Shuttle to ISS
- CEV to L_1
- LL to L_1
- CEV to ISS
- MMU
- Lunar Lander
- Lunar Habitat

• • •

BENEFITS
- Efficient Design
- Mission Safety
- Mission Analysis
- Cost Savings
- Schedule Reduction

System Design and Mission Simulation

An Integrated Program for Analysis and Design



System Design and Mission Simulation

Exploration Relevant Capabilities

Vehicle Design and Analysis

Engineering Level tools for conceptual development, assessment

- Trade Studies
- Requirements development and validation
- Design and packaging of new concepts
- Models and tools integrated with high fidelity tools for high confidence conceptual analysis
- Heating analysis and TPS sizing
- Controllability studies

High Fidelity Design Tools

- Integrated aerodynamic shape optimization
- Aerodynamic and Structural loads analysis
- Rapid re-design using intelligent database generation methods
  - Optimized data generation requirements
  - Data integration schemes

System Design and Mission Simulation

Exploration Relevant Capabilities, cont

Mission Simulation

Integrated, multi-disciplinary process

- Ascent to recovery
- Emergency abort and nominal separations including resultant stability and control analysis and trajectory optimization
- Nominal and failure-response re-entry flight characteristics and heating conditions
- Concurrent design and optimization of vehicle and control system

Integrated risk analysis

- Risk-driven simulations
- Simulation-based update of risk characteristics
- ISHM efficacy analysis

Flight Simulation Development and Integration

Integrated Flight Control System Development and Optimization

Piloted Simulation for situation prediction and recovery assessment

Integrated Mission simulations

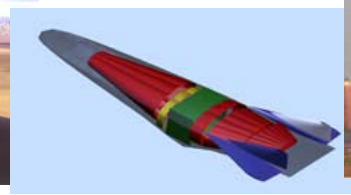
Collaborative tools

System Design and Mission Simulation

Applications Experience








Aerothermal Environments and TPS Sizing

- X-33
- X-34
- OSP Concepts
- Bantam Lifter
- MER

Vehicle Design

- Mars Airplane
- SHARP CTV and derivatives

Risk Assessment

- Mars Sample Return Re-entry risk assessment
- NGLT TSTO 2-Stage Concept
- JIMO

Trajectory Modeling

- SHARP CTV
- NGLT TSTO
- Bantam

Alternate Concept and Technology Evaluation

- NGLT TSTO and SSTO
- NASP
- Bantam

Flight Control System Optimization

- JSF
- UAVs
- CTV

Flight Simulation

- JSF
- SLI Concepts
- Rotorcraft

Life Cycle Analysis

- NASP
- CTV
- NGLT

System Design and Mission Simulation

An Integrated Process for High Confidence Conceptual Design

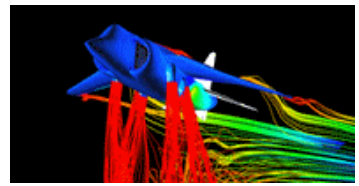
Flight Data

Flight Simulation

Distributed Collaboration and Simulation

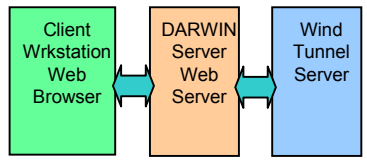
QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

Virtual Mission



Wind Tunnel Data

Control System Optimization



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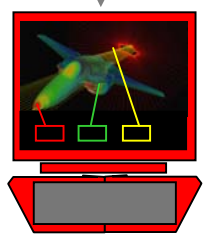
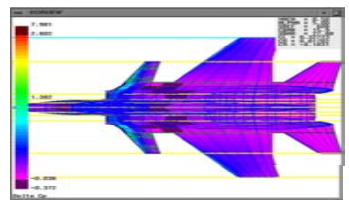




Design Optimization

High Fidelity Analysis

Aircraft Synthesis

System Design and Mission Simulation

Conceptual Vehicle Design

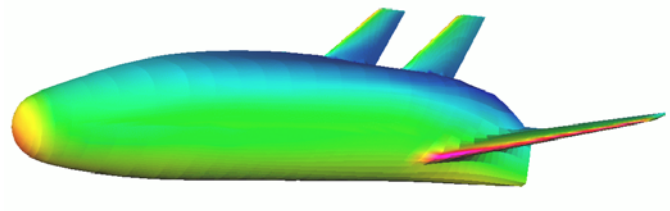
Flight Vehicle Analysis and Design: X-33 Aerothermal Design Database

Multi-discipline/Multi-fidelity

High Fidelity Used for Conceptual Design

Multi-discipline Products

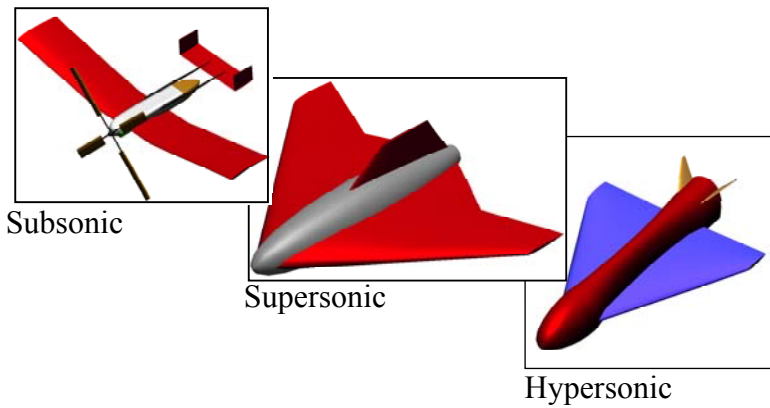
- Thermal/TPS
- Structures
- Trajectory
- Instrumentation



Novel Design Concepts

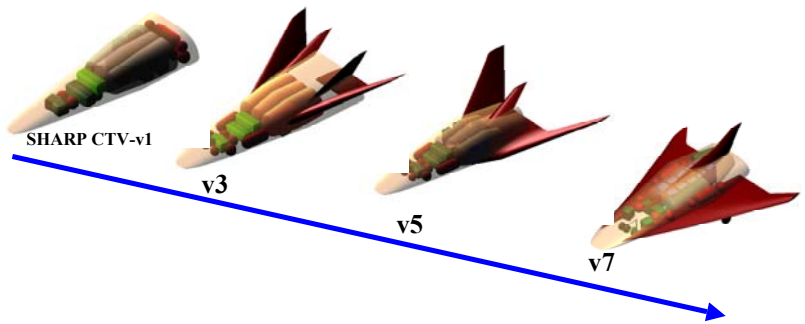
Mars Airplane

- Multiple concept/propulsion system designs
- Overall vehicle design and closure



SHARP CTV Design

- Multi-disciplinary design and optimization
- Extensive design cycle
  - » Engineering Analysis
  - » High Fidelity CFD
  - » Wind tunnel Testing
  - » Pilot-in-loop Flight Simulation & Evaluation



System Design and Mission Simulation

High Fidelity Mission Modeling

Separation
- Two-body 6 D.O.F. Simulation
- Simulated Explosion Effects
- Structural Response

Landing Site ID
- Aero/Aerothermal Database
- Trajectory Optimization

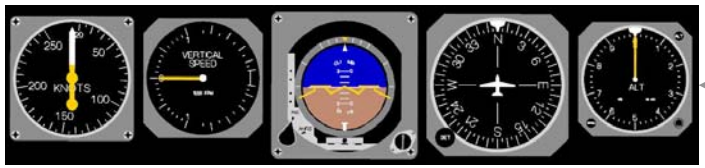
Risk Assessment
- Propulsion System PRA

Landing/Recovery
- Stab/Cont Database
- Control system
- Piloted Simulation

System Description
- Vehicle OML
- Propulsion system
- Structural model

System Design and Mission Simulation

Integrated Flight Control Optimization



Cockpit Display Development

Math Model Development

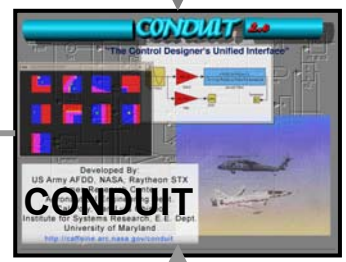
"RIPTIDE" SHARED MEMORY

A/C Mode

Flight Control Development

Controller

RIPTIDE/RTW Auto Coder



Desktop Simulation with Network I/O Capability

System Design and Mission Simulation

Integrated Flight and Mission Simulation

Module Design and Development
- Vehicle studies
- Control and display development
- Operational procedures
- Training

Mission Planning and Analysis
- Mission Visualization
- Visualization from any vantage point
- Virtual “Mission Control” center
- Design, evaluation, and training for actual control centers

System Design and Mission Simulation

Partnership Opportunities

Methods Development

- Integrated engineering level tools for exploration mission conceptual design
- Risk assessment and mitigation analysis methods
- Multi-disciplinary, multi-fidelity mission simulation and analysis
- Process management and intelligent database generation methods
- IT insertion analysis within engineering analysis methods for exploration
- Optimized collaborative processes and environments
- Life-cycle analysis tools

Studies and Designs

- Technology trade studies
- Mission simulation and analysis
- Risk assessment and mitigation studies
- Conceptual to preliminary design efforts